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Monitorování příjmu sacharidů ve výživě sportovců
Monitoring of carbohydrate intake in sportsmen's diet

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Podpis

Poděkování

Děkuji MUDr. Zdeňku Vilikusovi, CSc. za odborné vedení, cenné rady a připomínky při zpracování diplomové práce. Děkuji také všem dobrovolníkům, kteří mi s ochotou a důvěrou poskytli potřebné údaje a zpracovali záznamy jídelníčků a aktivity.

Abstrakt

Tématem mé diplomové práce je monitorování příjmu sacharidů ve výživě sportovců. Práce sleduje příjem sacharidů i ostatních živin podílejících se na celkovém příjmu energie, a to z toho důvodu, aby bylo možné zhodnotit, zda sportovci upřednostňují jiné zdroje hlavních živin před sacharidy a zda je jejich energetický příjem dostatečný. Sledováním příjmu vlákniny a jednoduchých cukrů je možné získat představu o tom, zda sportovci upřednostňují spíše rychle stravitelné zdroje sacharidů nebo v rámci snahy o zdravý životní styl dbají na příjem celozrnných výrobků, luštěnin, ovoce a zeleniny. Veškeré sledované údaje jsou porovnány s nesportovci, aby bylo zřejmé, v kterých ohledech se jejich dieta nejvíce odlišuje.

V teoretické části práce jsou definovány zásady sportovní výživy, krátce zmíněny rozdíly s doporučeními pro populaci a vysvětleny jednotlivé metody monitoringu příjmu a výdeje energie. V praktické části jsou pomocí software NutriPro Expert hodnoceny pětidenní jídelníčky sportovců a nesportovců. Pomocí databáze zvané Compendium of Physical Activities jsou hodnoceny záznamy veškeré fyzické aktivity v totožných pěti dnech u zkoumaných jedinců.

Veškeré zkoumané hodnoty, tedy příjem energie, výdej energie, příjem sacharidů, bílkovin a tuků, příjem jednoduchých cukrů, vlákniny a příjem alkoholu, byly srovnány s doporučeními pro zkoumaný vzorek a dále porovnány mezi sportovci a nesportovci. Cílem bylo zjistit jak míru plnění výživových doporučení pro sportovce, tak rozdíly mezi sportovci a nesportovci v příjmu jednotlivých živin.

Výsledky kvantitativního výzkumu ukazují, že rozdíly mezi stravováním sportovců a nesportovců skutečně existují. Přesto, že sportovci konzumují více sacharidů i jednoduchých cukrů než nesportovci, jejich příjem sacharidů je nedostatečný. Zároveň však nenahrazují sacharidy nadbytečnou konzumací bílkovin či tuků, proto lze předpokládat, že ideálním řešením by mohlo být zvýšení příjmu samotných sacharidů, které by mohlo podpořit i sportovní výkon.

Klíčová slova: sportovní výživa, sportovní výkon, energetický metabolismus, příjem sacharidů

Abstract

The topic of my master thesis is monitoring of carbohydrate intake in sportsmen's diet. In the thesis, intake of carbohydrates as well as other macronutrients is monitored in order to evaluate, if athletes prefer other energy sources to carbohydrates and if their total energy intake is sufficient. If athletes prefer easily digestible carbohydrates or if they follow recommendation for healthy diet and increase their intake of whole foods, legumes, fruits and vegetables can be evaluated by monitoring fiber and sugar intake. All the monitored data are compared with non-athletes in order to see, in which field their diets vary.

In the theoretical part, principles of sports nutrition are defined, basics of population recommendations are mentioned and methods of nutritional assessment and energy expenditure estimation are explained. In the practical part, five-day food-diaries of athletes and non-athletes are evaluated by NutriPro Expert software. Five-day physical activity diaries recorded during the same days are evaluated by using the Compendium of Physical Activities.

All the studied values (energy intake, energy expenditure, carbohydrate, fat, protein, sugar, fiber and alcohol intake) were compared to recommended values for athletes and non-athletes and further compared among these two groups. The goal was to find out how athletes fulfill nutrient intake recommendations as well as how their diet differs from non-athletes.

The results of the quantitative research show that there are differences between athletes' and non-athletes' diet. Even though athletes consume more carbohydrates as well as simple sugars than non-athletes, their carbohydrate intake is low. In the same time, the intake of other nutrients contributing to the total energy intake is sufficient, which could be a good reason to increase the intake of carbohydrates itself in sportsmen's diet and possibly further support the sport performance.

Key words: sports nutrition, sport performance, energy metabolism, carbohydrate intake

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1. Introduction

Sports nutrition is an important part of strategical improvement of sport performance. Athletes often show the willingness to support their performance by the proper nutrition. However, after an experience as a nutrition therapist in a sport medicine oriented center, I realized that athletes are often afraid of carbohydrates and they rather choose other macronutrients to cover their high energy expenditure. Furthermore, athletes often know about their increased need of protein, but they do not pay close attention to an increased need of carbohydrates. I noticed this problem across various sports both in endurance and strength athletes and in athletes oriented on dance performance or gymnastics. This is the reason why I decided to make a survey on sportsmen in general and not to divide them into smaller groups according to the sport practiced, even though their needs vary widely. I anticipate finding too low carbohydrate intake in athletes in general. Furthermore, even though some researches show optimal carbohydrate intake for certain groups of sportsmen, in my opinion, sports nutrition in the Czech Republic is not as developed as in some other countries and local athletes can still struggle with the issue of finding the right dietitian and information sources in general.

Finding out if athletes cover their carbohydrate need is not the only goal of this thesis. It is also important to see the intake of other macronutrients and alcohol intake.

I also assume that even though athletes may have problems in covering their carbohydrate needs, they tend to choose different sources of carbohydrates than non-athletes. Choosing only whole-corn products may not be the best idea for athletes because too high fiber consumption can increase the risk of a gastrointestinal discomfort during a performance. Sugar as a source of carbohydrates is not generally seen as a healthy choice for the population, although for athletes it is often the best source of easily utilizable energy before, during or after the performance.

I am also describing possible methods of energy intake and energy expenditure estimation, because they are often the limiting part of a research. Choosing the most suitable nutritional assessment and energy expenditure estimation method according to current financial situation, duration of a research and a size of the group can improve the accuracy of a research.

My master thesis is divided into a theoretical and a practical part. The first part contains information about energy needs of athletes, the macronutrient intake, alcohol intake and nutritional assessment methods. The differences with non-athletic population is briefly mentioned for comparison. In the second part, the results of the survey among athletes and non-athletes are presented. A conclusion is made according to the results.

I believe that this thesis will be a helpful tool for better understanding of the carbohydrate needs of athlete and their food habits in praxis. It can also be used as a basis for further and more detailed research, using more complex methods especially for the energy expenditure estimation.

2. Theoretical part

2.1. Sports nutrition

2.1.1. Energy requirement

The energy requirements of individual sportsmen vary according to their height, body size, age, muscle mass, type of training, training period and training load, individual goals, injuries, exposure to heat or cold, fear, stress, medication and possibly also the luteal phase of the menstrual cycle in women. Knowing the right energy requirements of an athlete helps achieving the performance goals, maintaining the optimal function of the body and covering the needs of nutrients. Energy intake also affects health and the function of immune and hormonal systems. Manipulating the energy intake helps managing the muscle mass and body fat levels in order to achieve an ideal body composition. A dietary plan for an athlete must consider limits such as food availability and gastrointestinal comfort (1, 2).

Each person needs a different caloric intake according to his or her lifestyle. The total energy expenditure (TEE) is a summation of the basal metabolic rate (BMR), the thermic effect of food (TEF), and the thermic effect of activity (TEA). Resting metabolic rate (RMR) can be used instead of BMR for a calculation and it is about 10 % higher. The difference between sedentary and active lifestyle in case of RMR is that it represents 60% - 80% of TEE for sedentary individuals and 38% - 47% for elite endurance sportsmen. TEA is a summation of planned exercise expenditure, spontaneous activity and non-exercise activity thermogenesis (2).

According to dietary surveys, male athletes usually report average daily intake between 12000 to 20000 kJ, female athletes 20-30 % less. However, even if the energy intake is expressed in kJ/kg, female athletes tend to eat less than male athletes. Endurance athletes tend to have higher energy intakes. According to Garcin who studied dietary intake among 63 various professional athletes, sprinters reported average daily intake 8626 ± 2646 kJ, endurance runners reported 10159 ± 3024 kJ and handball players 10252 ± 3330 kJ. The total caloric intake is lower than according to the Academy of Nutrition and Dietetics, American College of Sports Medicine and Dietitians of Canada, but Garcin's study is relatively small (1, 3).

Most of athletes also face periods of low or extremely high energy intake, depending on the period of training and managing body composition. In the periods of high energy requirements, some athletes consume nutrient supplements, to cover the needs of energy that cannot be easily covered by everyday meals. Sportsmen tend to voluntarily increase their energy intake after exercise (1, 3).

Some dietary surveys show very low energy intake among athletes. 122 American synchronized skaters reported average daily intake only 6964 kJ (4).

There appears to be a problem for some female athletes to cover the needs of energy, because of their fear of gaining fat or not losing fat in periods of weight-loss (1).

When energy intake is insufficient, fat and lean body mass is used as a fuel. Loss of lean body mass results in decreased strength and endurance. However, body mass loss of 0.02 % to 5.8 % in 30 days caused by negative energy balance was not associated with decreased performance in three studies. Another three studies proved that a slower body mass loss of 0,7 % was more beneficial to the performance than the fast one of 1.4 % (2, 5).

Few researches were undertaken about the dieting practice of athletes that want to reduce their fat free mass. Poor dietary quality, low carbohydrate availability, overtraining and dehydration were mostly found (2).

2.1.2. Nutrient intake

2.1.2.1. Carbohydrates

A great attention is paid to carbohydrate intake in sports nutrition. It has a specific role in the performance, adaptation to training and fatigue. The storage of carbohydrates in the body is small compared to fat and it can be widely manipulated by dietary intake and a load of exercise. Carbohydrate is also an exclusive energy source for the central nervous system, 1 g of carbohydrate equals 16,9 kJ. As a substrate for a muscle, it can be used in both anaerobic and aerobic pathways. Compared to fat, carbohydrate provides a greater load of ATP deliverable to the mitochondria per volume of oxygen, thus exercise becomes more effective. During a prolonged high-intensity exercise, the performance and level of fatigue can be strongly influenced by carbohydrate availability. Nutrition plans for athletes should consider carbohydrate loads before, during and after exercise (2).

Total carbohydrate intake should not be expressed in percentage of daily intake, because it varies widely among athletes, but in grams per kilogram of body weight (6). There are various situations and training phases in athletes' program and they must be considered in the guidelines. Recommendations for carbohydrate intake is described in detail in Table 1.

An official DACH-recommendation of consumption of more than 50 % of carbohydrates covered mostly by foods rich in starch and fiber is only partially valid for athletes. Less percentage of carbohydrate intake should by covered by fiber-rich foods than in non-athletes, because athletes' carbohydrate intake is generally higher than in sedentary individuals and higher amounts of fiber could cause gastrointestinal discomfort and affect the performance. The minimal amount of fiber consumption per day is 30 g for adults in general as a prevention of obstipation, colon diverticulitis, colon cancer, gallstones, overweight, hypercholesterolemia, diabetes mellitus and arteriosclerosis (7).

Carbohydrates are absorbed slower from foods containing fiber as well as protein and fat than from foods consisting of isolated carbohydrates. This fact is widely used when choosing meals before, during and after exercise and in times of reduced activity (7).

Situation	Recommended carbohydrate intake
Acute situation	
Optimal daily muscle glycogen storage for post-exercise recovery or to fuel up or carbohydrate load before an event	7-12 g/kg of body weight/day
Rapid post-exercise recovery of muscle glycogen, where recovery between sessions is <8 hours	1-1.2 g/kg of body weight immediately after exercise; repeated every hour until meal schedule is resumed. Series of small snacks every 15-60 min in the early recovery phase can be advantageous.
Pre-event meal to increase carbohydrate availability before prolonged exercise session	1-4 g/kg eaten 1-4 hours before exercise
Carbohydrate intake during moderate-intensity or intermittent exercise of >1 hour	0.5-1.0 g/kg of body weight/day in the amount of 30-60 g each hour
Chronic/everyday situation	
Daily recovery of fuel needs for athletes with light training program (low-intensity exercise or skill-based exercise). These targets may be particularly suited to athletes with large body mass or a need to reduce energy intake to lose weight	3-5 g/kg of body weight/day
Daily recovery of fuel needs for athletes with very light training program lasting up to 1 hour	5-7 g/kg of body weight/day
Daily recovery or fuel needs for endurance athlete (1-3 hours of moderate- to high-intensity exercise)	7-12 g/kg of body weight/day
Daily recovery or fuel needs for athlete undertaking extreme exercise program (>hours of moderate- to high-intensity exercise such as Tour de France)	≥10-12 g/kg of body weight/day

Table 1: Guidelines for Carbohydrate Intake by Athletes, adapted from Burke, 2007 (1)

Meeting the right carbohydrate intake is important during training and racing for most sportsmen, however, it is especially well described for cyclists and triathletes. Carbohydrate intake of 8-11 g/kg/day usually covers the needs for glycogen restoration for high-level cyclists and triathletes. Consuming 12 g/kg/day reported by some male cyclists proved higher glycogen stores than after consuming a diet with the intake of 10 g/kg/day (1).

High-level male cyclists reported their carbohydrate intake range from 8 to 11 g/kg/day. Women reported lower carbohydrate intakes than men – 9.8 g/kg/day on racing days, 8.9 g/kg/day on heavy training days and 7.5 g/kg/day on light training days. Another survey was made on collegiate cyclist during training and racing period and the carbohydrate intake was reported to be between 9 and 10 g/kg/day with higher intake during the racing days due to an increased fruit and bread intake. A study has been undertaken also on male triathletes, their daily intake of carbohydrates was reported to be around 9 g/kg/day. Some triathletes were educated after reporting low energy and carbohydrate intake (5 g/kg/day). Carbohydrate intake was increased to 9 g/kg/day and an improvement in performance in short-course race was observed (1). 244 Portuguese athletes also reported lower carbohydrate intake than recommended - slightly above 5 g/kg/day (8). Doering et al. made another research among 12 male Australian triathletes. The results were that the athletes consumed significantly less carbohydrates than recommended (3.6 g/kg/day) (9).

Some researchers studied the percentage of energy intake covered by carbohydrates. Ziegler et al. found that 122 American synchronized skaters cover 57% of the intake by carbohydrates (4), Baranauskas et al. write that 80,8% of 146 Lithuanian endurance athletes report lower carbohydrate intake than recommended (10), Nowacka et al. reports insufficiently low intake in 48,3% among 37 Polish female and in 35,2% among male canoeists. These canoeists were educated and questioned again and after the second session, their carbohydrate intake was insufficient in 40,2% among women and in 19,0% among men (11). Garcin compared the percentage of carbohydrate intake of athletes with a group of sedentary people and he found that athletes meet the recommended values, unlike sedentary people. 63 athletes covered 52-54% and 22 sedentary people only 46% of the daily intake by carbohydrates. (3)

Burke criticizes an opinion that appears among sportsmen. It says that most of top level athletes cover only about 50 % of their daily intake by carbohydrates instead of the recommended 60-65 %. They are then taken as an example of the best nutrition and training practice among lower level athletes. However, even professional athletes use various information sources and managing an optimal diet just by monitoring self-improvement in training and racing is a long-term process. Short-term improvement should not be overestimated (1).

For some athletes, consuming the recommended amounts of carbohydrates can be problematic. Benefits of carbohydrate-containing sport supplements have been proved in endurance sports, such as cycling, middle or distance running or triathlon, intermittent sports such as team and racket sports and high intensity sports lasting about 1 hour (1).

In order to optimize performance, athletes should distribute meals containing carbohydrates during the whole day, in order to provide fuel before, during and after the performance. It has been reported that some cyclists and triathletes are likely to fail to cover their daily carbohydrate needs, which results in poor performance or slow glycogen restoration and general fatigue (1). Glycemic index and load does not affect an endurance performance nor metabolic responses when an optimal amount of carbohydrate and energy is consumed (2).

Burke frequently mentions factors that challenge the ability to meet the recommended carbohydrate intake, including restriction of energy intake in order to maintain low body fat level, inadequate knowledge of nutrition skills and food composition, chaotic lifestyle and frequent travelling. In some countries, the availability of carbohydrate rich foods and drinks can be inadequate. Some carbohydrate rich foods also contain fiber, resulting in gastrointestinal discomfort. Each athlete should find a balance between optimal performance by covering all the carbohydrate needs and achieving optimal physique by restricting energy and thus also carbohydrates. Long-term goals should be considered in the first place (1).

2.1.2.1.1. Train low, compete high

Close et al. discusses the innovative model *"train-low, compete high" that* recommends endurance athletes to train with reduced carbohydrate availability during 3-10 weeks period. This model is supposed to augment training adaptation (adaptive remodeling of skeletal muscle, improvements in blood flow, improved ability to extract and utilize oxygen etc.) and maximize the competition performance with again high carbohydrate availability. He highlights that consuming carbohydrates including sucrose and fructose increase the carbohydrate oxidation rates to 1.8 g/min. However, he points out that sport nutrition can be divided into two fields – training and competition nutrition. Training with low carbohydrate availability is expected to have an effect on acute exercise-induced increase in cell signaling and gene expression responses and to lead to a coordinated upregulation of nuclear and mitochondrial genomes. The well-known effect of the long-term low carbohydrate availability, such as decrease in immune function, impaired training intensity, reduced ability to oxidize exogenous carbohydrates during performance and increased protein oxidation should be reduced by the way of well-planned training program. Intake of carbohydrates should be adapted to the workload, which means that athletes should consume enough carbohydrates 24 hours before the maximal training load and reduce the intake before a regular workout (12).

The "train low" strategy becomes generally recognized, but also potentially misunderstood (2).

2.1.2.2. Protein

Dietary protein is used as a source of energy and as a substrate for the synthesis of contractile and metabolic proteins and other tissues. 1 g protein equals 17 kJ (2).

The newest recommendation of protein intake ranges from 1.2 to 2.0 g/kg/day with a possibility to increase the intake during short period of intensive exercise or as a prevention of fat free mass losses during injury (2). This recommendation is different than the one for non-athletes, that is 0,8 g/kg/day (7). Daily protein intake should be spread across the whole day with specific intake after an exercise. Some sources criticize recent recommendations for protein intake and recommend much higher protein intakes in order to maximize metabolic adaptation to training (2). However, for maximizing the muscle growth, the maximal effect is observed while consuming 20 g of protein after resistance exercise. It can also be related to the size of an individual with 0.25 g/kg body mass (5).

It is recommended to adapt protein intake to training sessions and periodical program, rather than to categorize athletes as strength or endurance and recommend table values of protein intake. The suitable protein intake is based on experiences of an athlete, training program and carbohydrate and energy availability. Especially an adequate consumption of carbohydrate results in decreased protein oxidation and increased synthesis.

According to Genton et al., most athletes tent to over-consume protein, however, 20% of athletes have protein intakes below recommended values, mostly as an effect of wrong weight-loss programs and energy restrictions (6).

Foods rich in high quality protein also contains other important nutrients such as calcium in milk product or iron in meat, which is more advantageous to some protein supplements. Milk products, especially when they contain whey protein, have also the advantage of higher leucine content that is thought to help to stimulate muscle protein synthesis (12).

In monitoring the protein intake and needs, nitrogen balance is not as important for an athlete as for sedentary humans, because adaptation to training is the main goal. The adaptation probably occurs after stimulating the protein synthetic machinery in response to a rise in leucine concentrations and after the provision of amino acids that build a new protein (2).

2.1.2.3. Fat

Dietary fat is a source of energy (1g of fat equals 38 kJ), energy storage, essential elements necessary to build cell membranes and it helps the absorption of fat-soluble vitamins. Fat intake slows down gastric emptying and helps to cause the feeling of satiety after eating. Adipose tissue is the main energy source during fasting. The fat intake for athletes should meet the recommendations for public health and should be individualized based on physique goals and an athlete's training level (2, 13). DACH recommends fat intake below or equal to 30% of energy intake, with the possibility of increasing it to 35% in individuals with higher physical activity (7). Saturated fats should cover less than 10% of energy intake (2).

The intake of polyunsaturated omega-3 and omega-6 fatty acids is essential. The human body cannot synthesize α-linoleic and α-linolenic fatty acid and they must be present in the diet (14).

The maximum fat oxidation does not appear as a result of exercise adaptation, because it is further enhanced by fasting, pre-exercise intake of fat and a diet based on high-fat low-carbohydrate consumption. However, recent researches suggest that maximum fat oxidation occurs in moderate intensity performance supported by diets promoting high carbohydrate as a result of down-regulation of carbohydrate metabolism, even though glycogen is available. Although some researches point out an absence of disadvantages or even benefits of high-fat diets, in general, these diets result in reduced metabolic flexibility (2). Close et al. describes an increased performance after short-term low-carbohydrate, high-fat diet with up to 80 % of energy intake covered by fat, but he also mentions that long-term diet high in fat can decrease the utilization of glycogen stores and has no benefits for athletes (12).

On the other hand, some athletes choose to consume very low amounts of fat in order to maintain low body fat levels. Fat intake below 20 % of energy intake is often associated with low intake of other nutrients, such as fat-soluble vitamins or n-3 fatty acids. Low-fat diet should be practiced only in a short-term, such as the pre-event diet or carbohydrate-loading (2).

2.1.2.4. Alcohol

Moderate alcohol drinking can be a part of a healthy diet. However, excessive alcohol intake and binge drinking, commonly seen in team sports is inappropriate for sportsmen and can interfere with athletic goals. Alcohol has a negative acute effect on the performance itself, on the recovery phase and chronic effect on health and body composition. Alcohol contains 29 kJ/g and suppresses lipid oxidation (2).

According to DACH, the acceptable daily alcohol intake in healthy women is 10 g and in healthy men 20 g (7).

The absorption of alcohol starts in the oral cavity and continues in the stomach. The speed of alcohol absorption depends on its concentration in a beverage, stomach content, presence of CO_2 and the amount of fat in diet. Nearly all consumed alcohol undergoes biotransformation in the liver. The speed of alcohol elimination from the body is around 0,1g/kg/hour (14).

2.1.2.5. Micronutrients

The need of some micronutrients is increased after exercise. Especially the metabolic pathways and muscle biochemical adaptations require a certain amount of micronutrients. This deficiency may occur particularly in the athletes who often restrict energy intake, eliminate certain food groups from the diet or consume poorly chosen diets. The mostly deficient micronutrients are calcium, iron, vitamin D and some antioxidants (2).

2.1.3. Supplementation

Because athletes are major nutrition supplement consumers, they also became the main target of the supplement industry. The supplements promise to prolong endurance, support recovery, to help lose or gain weight, minimize the risk of illness and injury and achieve performance goals. Some athletes may believe that using supplements is necessary for the performance and forget about the possible negative effects (1).

Nutritional supplementation can be beneficial only if it corrects an unbalanced diet (8). Many athletes use supplements because they find it challenging to cover their energy intake sufficiently when they face challenges of everyday life such as lack of time or long-distance traveling. Athletes may benefit from the use of sports supplements in the following situations: Use of a supplement in order to meet nutritional needs, performance enhancing effect and/or placebo effect. The problems may arise from high costs of supplements, possibility of side effects, over-use, negative reactions or even toxicity should be considered, especially due to self-medication. Using too many sports supplements may result in insufficient diet with low intakes of other nutrients. Finally, performing athletes should be aware of supplements containing substances banned by the World Anti-Doping Agency. They should be listed among the ingredients; however, contamination can occur and has major consequences for an athlete (1).

Goston et al. studied intake of supplements among 1102 people exercising in fitness centers in Brazil. 36,8 % of participants reported intake of supplements in 4 months, 5 % consumed them daily. Most common were supplements rich in protein and amino acids (58 %), followed by isotonic drinks (32 %). Carbohydrate rich supplements reported 23 % of subjects. 55 % of the respondents used the supplements without any professional guidance with only self-prescription (15).

According to Sousa's et al. research, athletes who use nutritional supplements also report higher nutrient intakes from food and they were seen as the ones who would least benefit from it. The research was done among 244 Portuguese athletes from 13 various sports. 64% of them reported use of nutritional supplement in previous year. 71% of them were multivitamins or minerals, 59% sport drinks, 58% magnesium, 47% protein, 28% glutamine, 28% vitamin C, 24% iron and 21% sport gels (8).

2.1.3.1. List of Common Supplements

Carbohydrate-Electrolyte Drinks

A common name for carbohydrate-electrolyte drinks is simply sports drinks. They are flavored drinks that provide carbohydrates typically in an amount of 6-8 g/100 ml and sodium in amount of 10-20 mmol/l. They are used to hydrate organism during and after exercise and to provide easily digestible source of carbohydrates.

Electrolyte Replacement Supplements

Electrolyte-replacement supplements contain certain amount of sodium and other electrolytes such as potassium for replacement of electrolyte losses during and after exercise. They provide a rapid rehydration.

Liquid Meal Supplements

Liquid meal supplements contain powder rich in carbohydrates, moderate in protein and low in fat and they can be mixed with water or milk. Other than that, they are usually fortified with vitamins, minerals and essential amino acids. They are useful for athletes who need to increase energy intake during weight-gaining or undergoing heavy training loads. Due to a low amount of fiber, they do not cause gastrointestinal discomfort. Furthermore, they are practical for travelling athletes, especially in countries with inadequate food supply or hygiene.

Sports Bars

Sports bars are a compact source of protein and carbohydrate, while usually remaining low in fat and fiber. They can be fortified with vitamins and minerals. They are more concentrated source of nutrients than sports drinks and can be useful to provide energy during prolonged exercise, such as cycling or in a period of weight-gain. Sports bars are practical when athletes have limited space to carry large amounts of food. When consumed before an event, due to low amount of fiber, they provide sufficient source of energy with low risk of gastrointestinal discomfort. When eaten after exercise, they enhance regeneration. Athletes should only be aware of sports bars containing high amount of fat.

Sports Gels

Sports gels provide a concentrated source of carbohydrates in an easily digestible form. They usually contain 65-70 g carbohydrates in 100 g. Sports gels are practical in endurance sports when athletes carry only limited amount of food and drinks. They are low in fiber and prevent gastrointestinal discomfort. However, large amount of concentrated carbohydrate itself may cause discomfort. They should be always consumed with adequate fluid to prevent dehydration. Overconsumption of sports gels may lead to nutrient insufficiencies.

Multivitamin and Mineral Supplements

Micronutrient supplements can be used to cover insufficient nutrient intake by food and increased needs in a period of intensive training. Iron supplement is recommended in case of poorly chosen vegetarian diet, while increased losses during menses, gastrointestinal bleeding or excessive hemolysis caused by increased training stress. Calcium is recommended for athletes with insufficient intake of dairy products, for young athletes undergoing growth and for women with amenorrhea.

Creatine monohydrate

Creatine is a natural component of skeletal muscles. It plays a role in providing fuel supply in the muscle, especially important in sprinters and high intensity exercise lasting up to 10 s. In omnivore diet, there are around 2 g of creatine in a day, but vegetarians have reduced body stores of creatine and cannot compensate them from dietary intake. Creatine monohydrate supplementation seems to be beneficial for those who have lower initial creatine stores and has no further advantage for those with adequate stores.

Glutamine

Amino acid glutamine provides a source of fuel to immune cells and plays a major role in protein metabolism. It can provide an anti-proteolytic effect by stopping the catabolic effect of glucocorticoids. Glutamine supplementation is used either to boost the immune system or to support muscle gain in a period of intensive training. However, the evidence that would prove positive effects of glutamine supplementation is poor.

Medium-Chain Triglycerides

Medium-chain triglycerides are composed of fatty acids with a length of 6-10 carbon molecules. They are digested within the intestinal lumen and need less bile and pancreatic enzymes. After digestion, they are absorbed via the portal circulation and can be used as an energy source without the need for carnitine. They are less likely to deposit as body fat and can provide fuel during endurance exercise. However, their role as an energy substrate has not been well studied.

L-carnitine

Carnitine plays a role within fat and carbohydrate metabolism. It is often a component of fat loss supplements, because it is believed to enhance fatty acid transport and oxidation and spare glycogen. Although plasma concentrations were raised significantly after supplementation, muscle concentrations were not affected. Further research is needed, if carnitine could be taken up to muscle under different conditions (1).

2.1.4. Meal frequency

Right timing of meals supports optimal performance and optimizes training. It affects dehydration, electrolyte imbalances, glycogen stores, hypoglycemia, gastrointestinal discomfort and acid-base balance.

2.1.4.1. Pre-event eating

A single meal rich in carbohydrates taken 2-4 hours before performance improves muscle and glycogen stores and maintains blood glucose. The impact of a pre-event meal depends also on the time of recovery after last exercise. Some athletes may react to pre-event intake of glucose with hypoglycemia in the first 10 minutes of exercise with no effect on the performance. Those athletes should choose a pre-event meal containing fructose that lowers the glycemic index (6).

It is recommended to eat 200-300 g carbohydrates 3-4 hours before performance in meals short on fat, fiber and moderate in protein. Another recommendation is to take 1-2 g/kg carbohydrates and 0,15-0,25 g/kg protein during this period. Protein does not improve performance, but it may stimulate protein synthesis after resistance exercise (6).

2.1.4.2. Eating during an event

Meals taken during exercise provide available exogenous fuel when endogenous glycogen stores become depleted. The meal should be easily portable, ready to eat and not cause gastrointestinal upset. Positive effect of carbohydrate intake during exercise has been proven by many studies, it delays exhaustion and improves performance. It helps to spare glycogen stores, supports carbohydrate oxidation and maintains blood glucose (6). Consuming foods with high glycemic index increases insulin secretion, but it does not cause hypoglycemia as it would cause during a pre-event meal (13). Exogenous carbohydrate oxidation was greater after consuming glucose or glucose and fructose during exercise compared to water placebo during exercise. Carbohydrate oxidation was greater after consuming glucose and fructose mix compared to glucose only, but the evidence is limited (2).

The amount of carbohydrates needed to improve performance may vary from 16 to 75 g/h. Higher doses are not beneficial. Glycogen degradation may decrease by 49% after supplying 1 g/kg carbohydrate before and 0,5 g/kg every 10 minutes during 40 minutes lasting resistance training. The interval for carbohydrate intake may vary from 10 to 60 minutes without any difference in the effect, however, recommended interval is 15-20 minutes (6).

2.1.4.3. Post-event eating

The purpose of post-event meat is mainly to enhance recovery. Carbohydrate intake speeds up the synthesis of muscle glycogen stores, especially when the meal is consumed immediately after an exercise. Carbohydrates consumed in a meal with high glycemic index help to maintain greater muscle glycogen storage in 24 hours after an exercise. The type of carbohydrates also influence the speed of glycogen synthesis. Glucose and sucrose help to maintain the glycogen stores faster than fructose. Frequency and solid or liquid form of carbohydrate intake has no influence, as long as the total intake is sufficient (6). In a post-exercise snack, carbohydrates consumed with proteins are recommended. This combination has the same effect like carbohydrates alone on the rate of a muscle glycogen synthesis, post-exercise muscle soreness, subsequent strength and sprint power. However, it improves the net protein balance, leads to an accelerated recovery in static force and dynamic power production during delayed beginning of muscle soreness and it leads to an increased body and muscle mass synthesis and improved nitrogen balance (2). The type of proteins can play a role, whey and soy protein shows higher effect on muscle protein synthesis than casein. Whether the protein meal is consumed 1 or 3 hours after exercise plays no role, but the response is delayed with the higher age of an athlete (6).

Muscle protein is synthesized for at least 24 hours after an exercise and the use of dietary protein is increased in this period of time. The official guideline specifies that it is recommended to provide approximately 10 g of essential amino acids in the first two hours after an exercise in order to maximize the response to the exercise. This can also be covered by an intake of 0.25-0.3 g/kg of body weight or 15-25 g of protein consumed in this period. Doses higher than 40 g consumed in this early phase of recovery have no proven benefits. In order to maximize exercise adaptation, doses of 0.3 g/kg of body weight should be consumed every 3-5 hours as a part of a regular meal in the 24 hours after a training session (2).

2.1.5. Energy Pathways

Which fuel is used during an exercise depends on the time and the intensity of an activity. It includes non-oxidative pathways - phosphagen and glycolytic, and aerobic pathways – fat and carbohydrate oxidation. During an exercise lasting up to 10 seconds, a rapid energy source of both ATP and phosphocreatine are used for muscle contraction. From about 10th to 180th second of an exercise, glucose and muscle glycogen are the main sources of energy in the glycolytic cascade. During exercise lasting longer than about 2 minutes, oxidative pathways provide the primary fuel for muscle contraction with muscle and liver glycogen and amino acids from muscle, blood, liver and the gut. Later also intramuscular lipids and adipose tissue triglycerides become the main sources of energy. The more oxygen available to the working muscle, the more the body uses the aerobic (oxidative) pathways and the less the anaerobic (phosphagen and glycolytic) pathways. There is no exclusivity and more pathways are always being used in one time. The intensity, frequency and duration of the exercise, sex, training level and nutrient intake determine the intensity and priority of each energy pathway (2).

2.2. Main differences among athletes and non-athletes

2.2.1. Energy requirement in non-athletes

BMR in non-athletes is usually lower due to lower amount of lean body mass. An average energy intake normative in non-athletes with sufficient physical activity and optimal body mass index (BMI) is listed in Table 2. However, recommendations of energy intake for the public vary between 7500-13000 kJ/day depending on age and sex (7).

Age (years)	Male	Female
15-18	195	180
19-24	170	165
25-50	165	165
51-64	145	145
≥65	140	135

Table 2: An average energy intake normative for non-athletes with sufficient physical activity and optimal BMI (kJ/kg of body weight) (7)

Zlatohlávek writes that energy expenditure is divided into three parts, while basal metabolic rate accounts for 60%, physical exercise for 30% and thermal effect of food for 10% of total energy expenditure (14). This cannot be considered in sporting individuals, because physical exercise proportion is much higher than 30%.

2.2.2. Macronutrient intake

Recommended protein intake for healthy non-athletes is 0.8 g/kg of body weight. It contributes to the total energy intake by 9-11%, 15% is also tolerated and easier realized.

Individuals with light and medium-high physical activity should not exceed covering 30% of their total energy intake by fat.

More than 50% of the total energy intake should be covered by carbohydrates. Daily fiber intake should exceed 30g. Sugar intake should not contribute more than 10% of the total energy intake (7).

2.3. Nutritional Assessment

Nutritional assessment methods are used for monitoring nutrient intake of individuals and groups. Duplicate meal analysis is the only ideal method measuring the accurate energy intake, however it is highly impractical (17). There is a common disagreement about which method of nutritional assessment is the most valid and which technique is the right one for various kinds of studies. The validity of dietary recalls relies on how accurately the respondents can record their intake, how they cooperate and how accurate is the nutrition database system. (18).

An energy intake of an individual can be derived from typically 3-7 day weighed food records, a 24-hour recall, a diet history or a food frequency questionnaire. Limitations exist within all of these methods.

While monitoring the energy intake of athletes, misreporting and especially underreporting of total energy intake must be considered (1).

2.3.1. 24-hour Recall

In this method, respondents are asked to list estimated portions of foods and beverages consumed on the previous day. A trained interviewer is required in this method. He or she asks additional questions in order to get an accurate information (17, 18). An error can be made in the process of recall, portion estimation, conversion the stated portion size to grams and milliliters and calculation, as well as due to inaccuracies in the nutritional databases used. (17)

A 5-pass method was created to be used in the interview. The first step is that a respondent is asked to list everything eaten and drunk on the previous day. In the next step, the list is red in order to remember forgotten items. In the third step, the time and name of the meals are listed. In the fourth pass, a detailed description of portion sizes is collected and the interval between meals is reviewed. In the final pass, the interviewer presents standardized food pictures or models in order to compare the portions and review the data. (18)

24-hour recall is made to increase the validity of data collection though the interview conducted by trained professionals. It brings an advantage compared to a self-report questionnaire. However, food intake of healthy people varies each day with a coefficient of variation of about 25%. The variation in food intake has a periodicity of about 3-6 days (16, 18).

Self-administered online recall was studied by Frankenfeld et al. They compared a self-administered online 24-hour recall system with 4-day diet record and analyzed, if the time-saving online record could replace the 4-diet record as it is time-consuming and not very practical for larger studies, because it needs to be done by a person trained to collect and analyze information. College students were chosen as participants in the survey. For the 4-day food records, instructions were given to the participants, telling them when to start monitoring their intake, how to write down the information, reminding the commonly forgotten items such as gum or water, giving them instructions how to record food supplements and helping with measuring the amount of consumed food by a guide with pictures of portions. Example of one-day record was given. Participants filled prepared columns, including date, day of the week, meal, time of the meal, place, food, preparation of food, drinks and serving size. Three work days and one weekend day were included. Two weeks after completing the 4-day diet record, the participants were asked to fill online National Cancer Institute Automated Self-Administrated 24-Hour Dietary Recalls, one for a weekday and one for a weekend day. After collecting all the records, mean intake of each nutrient was calculated. The mean energy and macronutrient intake varied only slightly and for carbohydrates, the mean value was exactly the same for both methods of the survey. The amount of alcohol and micronutrients varied more widely among the methods. However, self-administered 24-hour recall was proved to be an accurate tool to evaluate the intake of nutrients (19).

2.3.2. 3-7 Day Food Record

Food record is a traditional diet assessment that measures food intake of respondents on a self-record basis. The subjects are asked to report all consumed foods and beverages in a typical period of 3, 5 or 7 days. Unlike in 24-hour report, respondents record the meals at the time of consumption. Food and beverages should be measured either by using household measures, by weighing each item or by comparison to model portions. All ingredients should be listed with the time of consumption. The method relies less on memory; however, it may affect usual eating habits. A typical food record involves at least one weekend day, because the eating patterns may differ from work days.

The method has several limitations. Respondents may forget or fail to provide sufficiently detailed record and they tend to underreport foods commonly considered as unhealthy. Many individuals fill out the report at the end of the day as a consequence of lack of time or simply forgetting. Food record requires a high degree of compliance (17, 18).

Food record is the cheapest method of dietary assessment.

2.3.3. Dietary History

Using a dietary history method, respondents are questioned by a trained professional about the frequency of consumption of various food and beverages, more and less typical content of meals and detailed preparation of meals. The method is expensive and time-consuming (18).

2.3.4. Food Frequency Questionnaire

Food frequency questionnaire is a method where respondents are asked to mark how often they have consumed a specific food and beverage during a certain period of time, usually between 6 and 12 months. Bronner describes also shorter periods of time – past day, week or month. Food frequency questionnaire captures nutritional patterns of individuals or groups. The format is questionnaire-based and respondents select an option from a given list. This method is not very sensitive to specific food and beverage kinds, as well as culinary methods, portion sizes and meal frequency. Food frequency questionnaire usually lasts 40-60 minutes and can be self-administered. It is not an expensive method. (17, 18)

This method is usually used by researchers studying trends in food consumption over a longer period of time, while studies lasting up to 6 months use food records or 24-hour recall.

2.3.5. Misreporting Energy Intake

A significant problem of all the dietary surveys is misreporting of energy intake. When the results show extremely low or high values and the participants maintain a long-term weight stability, the resulting energy intake is likely to be misreported or the survey was possibly undertaken in random days during which energy intake varies widely (20). A large amount of literature has been devoted to examining the circumstances under which respondents tend to misreport their intake. Overweight individuals tend to underreport intake to a greater degree than athletic individuals and women under-report their intake more often than men (18).

Various researchers found that cyclists underreported up to 9 snacks each day, the underreported energy can be up to 40 % of daily energy intake (1).

Scagliusi et al. studied underreporting and the possibilities to reduce this behavior among 35 Brazilian women. Energy intake was monitored by a 7-day diet record and energy expenditure calculated by heart rate monitoring. When energy the ratio of intake and energy expenditure was lower than 1 and the subject did not lose weight in one month, it was considered as under-reporting. Then the results were correlated with anthropometrical data, behavior and psychological parameters. 17 women (almost 50 % of the subjects) under-reported the energy intake by the average of 21%. These under-reporters were trained and educated about reporting the energy intake and then they were tested again. Under-reporting was reduced to 33%. The results are that commonly under-reported foods are the ones considered unhealthy and that under-reporting can be reduced by a training program that helps the subjects to feel confident about reporting unhealthy food, also portion size measurement aids can be helpful to reduce under-reporting. The main characteristics of under-reporters were that they commonly wished to lose weight and 80% of them had already tried a restrictive diet in past (21).

Black and Cole were studying the characteristics of people misreporting energy intake. Studies that have been taken on this topic measured estimated energy intake and compared it with reported intake. Basal metabolic rate was estimated and physical activity level added in 3 studies and 24-hour urinary nitrogen was measured in 2 studies to provide the comparison. The studies were based on 28-day weighed record and doubly labeled water method used to estimate the energy expenditure. These studies were searching if there are any differences according to the stage of study, calendar month, age, sex and dietary assessment method. The result was that a person who underreported the energy intake once was likely to be an under-reporter in other occasions as well. Having highly motivated volunteers in the study was also not a guarantee of valid dietary reports. Increased frequency of underreporting was observed by pregnant women according to the stage of pregnancy, increasing as pregnancy progressed (20).

Millen et al. made a similar study using the food frequency questionnaire. Subjects reported consuming a food group by marking “yes” or “no” to the consumption, how frequently per day they consume the food group and how big is their portion size (small, medium or large). Total energy expenditure was analyzed by double labeled water technique and compared with reported energy intake. The food frequency questionnaire that has been used in this study is available online at https://epi.grants.cancer.gov/DHQ/. The results shown that among 450 random participants in the age of 40-70, 220 were identified as low-energy reporters, 220 as non-low-energy reporters and 10 as high-energy reporters. The most significant differences between low-energy reporters and non-energy reporters were observed in the frequency of food reported (22).

Underreporting cut-off index is usually set at 0.9 (8).

2.4. Human energy expenditure

Human nutrition expenditure is an important value for counting the energy needs of athletes and sportsmen. Direct calorimetry is limited to only laboratory conditions, indirect calorimetry is reliable and relatively easy to measure, but it cannot be used in everyday basis. Doubly labeled water is accurate and convenient, but only in a long-term measurement. Self-reporting is described as highly unreliable; however, it has the lowest costs and it is practical for larger studies. Ubiquitous monitoring systems are recently becoming a practical solution for measuring physical activity and indirect measuring of metabolic activity, their main advantage is that they can be wearable during the athlete's activity (23).

Self-reported physical activity must be comparable across studies. For this purpose, The Compendium of Physical Activities was developed. It contains 821 codes for specific sport activities and 561 of them have measured MET values. 1 MET is described as the metabolic cost of resting quietly. It is recommended to divide the fixed RMR (3.5 $ml^{-1}\times kg^{-1}\times min^{-1}$) by RMR predicted from the Harris-Benedict equation listed as Equation 1 and 2. The result is in kcal. Although some articles identify the Harris-Benedict equation as representing basal metabolic rate, the truth is that the measures were undertaken in resting conditions, not basal (24). Another often discussed topic is using Harris-Benedict equation in obese individuals. Some dietitians still use an adjusted body weight or ideal body weight; however, it can underestimate the energy expenditure as much as 42%. Using the actual body weight is recommended (25). The result can then be divided into hours or minutes and multiplied by the Compendium MET values. The Compendium was made for adults across the world for research studies, clinical settings, for physical activity recommendations according to energy expenditure and to quantify the energy costs of various sports. Each activity has its own five-digits code that includes the intensity of an exercise. The major activities are divided in 21 types listed in Table 3 (26).

$$66.5 + (13.75\times kg) + (5.003\times cm) - (6.775\times age)$$

Equation 1. Harris-Benedict equation for men (27).

$$655.1 + (9.563\times kg) + (1.850\times cm) - (4.676\times age)$$

Equation 2. Harris-Benedict equation for women (27).

1	Bicycling	8	Lawn and garden	15	Sports
2	Conditioning exercises	9	Miscellaneous	16	Transportation
3	Dancing	10	Music playing	17	Walking
4	Fishing and hunting	11	Occupation	18	Water activities
5	Home activity	12	Running	19	Winter activities
6	Home repair	13	Self-care	20	Religious activities
7	Inactivity	14	Sexual activity	21	Volunteer activities

Table 3: Major types of physical activities listed in the Compendium of Physical Activities (19).

An example of using the Compendium is given: "For example, if an adult wanted to follow the US PA guidelines to accumulate 150 min of moderate-intensity PA and engage in 2 d of strength training activities, an individual could perform the following plan: Monday, walk at 3.0 mph for 30 min (code 17190, 3.5 METs); Tuesday, lift weights for 20 min (code 02054, 3.5 METs); Wednesday, bicycle at 9.4 mph for 40 min (code 01019, 5.8 METs); Friday, lift weights for 20 min (code 02054, 3.5 METs); Saturday, attend a low-impact aerobic dance class for 40 min (code 03020, 5.0 METs); and Sunday, rest." (26). All the activities are listed in the website: https://sites.google.com/site/compendiumofphysicalactivities (28). An example of activities is given in Table 4.

Codes	METs	Description
01004	16.0	Bicycling, mountain, competitive, racing
03016	7.5	Aerobic, step, with 6-8-inch step
10040	3.8	Drums, sitting
17021	2.3	Carrying 15 lb child, slow walking

Table 4: Example of activities.

3. Practical Part

3.1. Research Goals

The main goal of this research is to evaluate the (in)sufficiency of carbohydrate intake of athletes. High energy expenditure requires high energy intake and some athletes may have problems meeting the needs of energy and nutrient intake. Furthermore, athletes need much more carbohydrates than non-athletes and their diet should differ widely, so the goal is also to compare the carbohydrate intake with non-athletic population.

Even though the research is focused mainly on carbohydrate intake, it is necessary to compare it with the total energy intake and the intake of protein, fat and alcohol. The goal is to see how the energy intake is fulfilled in case of carbohydrate intake insufficiency.

To get a closer picture of the type of carbohydrates consumed, sugar and fiber intake is evaluated and compared.

3.2. Research Hypotheses

Hypotheses were defined according to the research goals.

Hypothesis 1: Athletes have insufficient energy intake compared to their energy expenditure.

Hypothesis 2: Non-athletes have higher energy intake than energy expenditure.

Hypothesis 3: Athletes have an insufficient carbohydrate intake, even though they consume more carbohydrates than non-athletes.

Hypothesis 4: Fiber intake is insufficient in both athletes and non-athletes.

Hypothesis 5: Sugar intake is higher in athletes than in non-athletes.

Hypothesis 6: Protein intake is higher than required in both athletes and non-athletes.

Hypothesis 7: Fat intake is within the recommended range in athletes and higher than required in non-athletes.

Hypothesis 8: Alcohol consumption is lower in athletes than in non-athletes.

3.3. Research Methodology

3.3.1. Respondents

20 sportsmen and 20 non-athletes were asked to fill out a food and activity record. Sportsmen participating in the study were sought out in various online groups and discussion platforms oriented on sports. Members of groups concentrating on endurance sports, strength sports, gymnastics, dance and collective sports were asked. The goal was to get a random group of participants and not to concentrate only on one type of a sport. The criteria were that athletes should train at least four times a week in long term and they should not be currently in a weight loss or a weight gain program. Number of participants per each sport is listed in Table 5.

Sport	Number of participants
Athletics	4
Basketball	3
Climbing	2
Gymnastics	2
Running	2
Weight lifting	2
Ballet	1
Cycling	1
Golf	1
Skiing	1
Swimming	1

Table 5: Participating athletes

Non-athlete participants were searched randomly among neighbors, colleagues and their connections. The criteria were that the non-athletes should do sports only recreationally not more than three times a week or not more than 30 minutes each day in average and they should not be following any special diet at the time of data collecting.

The characteristics of all participants is listed in Table 6. Because body weight is important for counting the right carbohydrate intake especially for sportsmen, body weight and height are listed in Table 7.

	Sex		Age				BMI			
Participants	Male	Female	Average	Min	Max	Median	Average	Min	Max	Median
Athletes	5	15	27,5	17,0	42,0	23,5	22,5	17,7	34,6	22,4
Non-athletes	11	9	33,9	21,0	62,0	31,5	25,3	19,2	34,0	24,1

Table 6: Sex, age and BMI of participants

	Body weight				Body height			
Participants	Average	Min	Max	Median	Average	Min	Mag	Median
Athletes	65,0	41,0	100,0	66,5	169,5	152,0	188,0	171,5
Non-athletes	76,8	54,2	104,0	72,35	173,7	160,0	194,0	173,0

Table 7: Body weight and height of participants

3.3.2. Data Collecting Methodology

A guideline to food and activity report was made (see appendix). Respondents were asked to fill it out five days in a row, including at least one weekend day. They were given instructions via e-mail. They also received an excel table with prepared columns for food, beverages and a physical activity. However, a record on a paper or phone was also possible, because it allows respondents to note down the meal immediately after consumption.

All respondents were asked to report their height, age, sex and weight on the first day of the report and the weight after the last day of the report and an average of the two figures was used. They were instructed to note the meal in the time of consumption to eliminate errors caused by not remembering all the ingredients in the end of the day. However, the meal frequency was not questioned. They could use a scale and/or household measures to estimate a portion size. A list of household measures was given to the respondents to increase the level of cooperation and precision. In case of physical activities, respondents were informed that the Compendium of Physical Activities will be used and they can find their activity themselves. They could either list the activity or only the MET value, in case they do not want to share the detailed activity program.

3.3.3. Research Flow

The topic was chosen in October 2016. The theoretical part was written in December 2016. After getting to know the information about sports nutrition and methodology of energy intake and energy expenditure estimation, the methodology for this research was chosen.

Cooperative athletes and non-athletes were sought out between December 2016 and April 2017. Respondents filled out a food and physical activity report for 5 days and sent it to a given e-mail address until May 2017 with a possibility to ask questions and consulting protentional troubles with the report. In the following week after receiving report, respondents were asked additional questions about foods that are frequently forgotten: oil, alcohol beverages, sweetened drinks, potato chips and other snack foods etc.

All food and activity reports were calculated in the following week after receiving, by using Nutri Pro Expert software and the Compendium of Physical Activities. The results were transferred to Microsoft Excel and evaluated statistically.

3.3.4. Data Evaluation

Research was done quantitatively by evaluating collected reports. Food diary was evaluated by using NutriPro Expert software. One way to use the software is to let respondents fill out their dietary report themselves. However, time requirement of this activity and a lack of experiences with dietary reports can lead to increased misreporting of energy intake. Furthermore, since respondents were asked additional questions about their food diary, I evaluated the data myself.

Total energy intake, protein, carbohydrate and fat intake, alcohol income, fiber intake and sugar income were evaluated. Percentage of protein, carbohydrate, fat and alcohol of total energy intake was calculated. Percentage of sugar of total carbohydrate intake was calculated. Coefficient 0,9 for underreporting the energy intake was considered and new data calculated. However, both original and adapted data were used and evaluated.

Energy expenditure was calculated using the Harris-Benedict equation in order to get the resting metabolic rate. Evaluating the physical-activity diary by using METs values from the Compendium of Physical activities followed. The average value was calculated from the 5-day report.

All values were then statistically evaluated using t-test for two-sample assuming either equal or unequal variances. The equality of variances was evaluated using f-test for equality of variances. T-test evaluates mean values of two groups that are a part of one studied database, for example energy intake values. The P value evaluates if the difference is considered to be statistically significant ($P \leq 0,05$) or nonsignificant ($P > 0,05$).

Athletes were compared to non-athletes and both groups separately were compared to reference values for energy intake for carbohydrates, protein, fat, fiber and alcohol.

All results are listed in tables with a short comment. According to the results, the discussion is written.

3.3.5. Problems appearing during the research

There were no problems during writing the theoretical part of the thesis. All necessary references were accessible and easily found though e-resources such as Science Direct or Web of Science. Some literature was ordered from abroad, because it was not available online or in the libraries. This literature is handy in further career.

During the practical part, there was a few problems that prolonged the data collecting period. Even though around 50 athletes agreed to fill the food and activity report in the beginning, most of them found the report too time consuming, especially because of the detailed physical activity report. Some of them found the physical activity report too personal and refused to note every activity, even though there was a possibility to note only a MET value. There were no problems with filling the food diary, probably because most of the athletes were used to writing the food reports as a part of their training. However, additional questions were often necessary, for example when a respondent noted bread with butter and ham as one food item and it was not clear how much bread, butter and ham he or she used.

Non-athletes appeared more cooperative during filling out the reports. However, further explanation of the method was often necessary, because they had no experiences with filling such reports. The higher degree of cooperation can be explained by the curiosity of respondents to see the results of their reports, that were available for them after evaluating.

Working with Nutri Pro Expert software usually went without complications; however, it was often necessary to add some foods that were not available in the database. This method was rather time consuming, because it was necessary to find online the nutritional values of a specific food noted by a respondent. All the obtained data had to be transferred from the software manually to an Excel file. Further processing of data ran without complications.

3.4. Results

3.4.1. Energy intake and energy expenditure

As shown in Table 8, there is no statistically significant difference between the reported energy intake of athletes and nonathletes.

Energy intake		
	Athletes	Non-athletes
Arithmetic mean value	9275	9533
Minimum	3882	5342
Maximum	13406	14551
P(T<=t)	0,7387	

Table 8: Energy intake

As shown in Table 9, athletes have higher energy expenditure than non-athletes.

Energy expenditure		
	Athletes	Non-athletes
Arithmetic mean value	11622	9574
Minimum	8183	7736
Maximum	16585	12966
P(T<=t)	0,0007	

Table 9: Energy expenditure

As shown in Table 10, non-athletes cover more of their energy expenditure by their energy intake than athletes. There is no significant difference between the energy intake and energy expenditure in non-athletes, which means that they cover their energy expenditure successfully. Athletes do not cover their energy expenditure successfully, because the difference between energy intake and energy expenditure is significant. Also, the difference is a negative value, which shows that the energy balance is negative.

Difference between the energy intake and the energy expenditure (kJ)			**Difference between energy intake and energy expenditure in athletes (kJ)**		**Difference between energy intake and energy expenditure in non-athletes (kJ)**	
	Athletes	Non-athletes	Energy intake	Energy expenditure	Energy intake	Energy expenditure
Arithmetic mean value	-2348	-41	9275	11622	9533	9574
Minimum	-6011,0	-3628	3882	8183	5342	7736
Maximum	511	3352	13406	16585	14551	12966
P(T<=t)	0,0005		0,0010		0,9499	

Table 10: Difference between the energy intake and the energy expenditure

However, if a coefficient for underreporting the energy intake is used, which assumes that subjects report only 90 % of their intake, the results change significantly. As shown in the Table 11, athletes cover their energy expenditure successfully when underreporting is considered. Results for non-athletes do not change after considering underreporting.

Difference between the energy intake and the energy expenditure considering underreporting (kJ)			Difference between energy intake and energy expenditure in athletes considering underreporting (kJ)		Difference between energy intake and energy expenditure in non-athletes considering underreporting (kJ)	
	Athletes	Non-athletes	Energy intake	Energy expenditure	Energy intake	Energy expenditure
Arithmetic mean value	-2348	-41	10305	11622	10592	9574
Minimum	-6011,0	-3628	4313	8183	5937	7736
Maximum	511	3352	14896	16585	16168	12966
P(T<=t)	0,0005		0,0876		0,1521	

Table 11:Difference between the energy intake and the energy expenditure considering underreporting

3.4.2. Carbohydrate intake

In terms of percentage of total energy intake, athletes consume more carbohydrates than non-athletes, as shown in Table 12 and Table 13. Athletes, but not non-athletes reached the DACH recommendation to cover more than 50 % of the energy intake by carbohydrates. However, as described in the theoretical parts, total carbohydrate intake should be expressed in grams per kilogram of body weight for athletes.

Percentage of carbohydrates covering the total energy intake			Meeting DACH recommendations	
	Athletes	Non-athletes	Athletes	Non-athletes
Arithmetic mean value	49,8	45,0		
Minimum	42,8	32,3		
Maximum	65,2	54,0		
P(T<=t)	0,0128		0,8533	0,0015

Table 12:Percentage of carbohydrates covering the total energy intake

Athletes consume more carbohydrates per kilogram of body weight than non-athletes. The average amount of carbohydrates consumed by athletes, 4,3 g/kg of body weight, corresponds with the recommendation: For daily recovery of fuel needs for athletes with light training program (low-intensity exercise or skill-based exercise). These targets may be particularly suited to athletes with large body mass or a need to reduce energy intake to lose weight (1). Athletes were chosen not to be in a weight loss program, which means that this amount of carbohydrates consumed is too low for studied athletes.

Grams of carbohydrates per kg of body weight		
	Athletes	Non-athletes
Arithmetic mean value	4,3	3,4
Minimum	2,2	1,5
Maximum	7,0	5,4
P(T<=t)	0,0148	

Table 13: Grams of carbohydrates per kg of body weight

Fiber consumption is shown in Table 14. There is no statistically significant difference between fiber consumption in athletes and non-athletes. However, athletes reached the minimal value of fiber consumption recommended by DACH (30 g per day). Non-athletes did not meet this recommendation.

Fiber consumption			Meeting DACH recommendations	
	Athletes	Non-athletes	Athletes	Non-athletes
Arithmetic mean value	26,5	20,9		
Minimum	12,7	8,6		
Maximum	62,0	42,9		
P(T<=t)	0,0698		0,2002	0,0000

Table 14: Fiber consumption

As shown in Table 15 and Table 16, athletes choose sugars as a source of carbohydrates more likely than non-athletes.

Percentage of sugar contributing on the total carbohydrate intake		
	Athletes	Non-athletes
Arithmetic mean value	34,9	25,9
Minimum	20,4	8,6
Maximum	68,9	42,9
P(T<=t)	0,0062	

Table 15: Percentage of sugar contributing on the total carbohydrate intake

Percentage of sugar contributing on the total energy intake		
	Athletes	Non-athletes
Arithmetic mean value	17,2	11,7
Minimum	9,9	2,9
Maximum	31,6	20,0
P(T<=t)	0,0010	

Table 16: Percentage of sugar contributing on the total energy intake

3.4.3. Protein consumption

As shown in Table 17 and Table 18, athletes cover more of their energy intake by protein than non-athletes. Athletes met the range of recommended protein intake (1.2-2-0 g/kg/day). Non-athletes did not meet the DACH recommendation (0,8 g/kg/day).

Percentage of protein covering the total energy intake		
	Athletes	Non-athletes
Arithmetic mean value	19,2	16,0
Minimum	12,8	11,5
Maximum	33,0	25,4
P(T<=t)	0,0164	

Table 17: Percentage of protein covering the total energy intake

Grams of protein per kg of body weight			**Meeting protein intake recommendations**
	Athletes	Non-athletes	Non-athletes
Arithmetic mean value	1,6	1,2	
Minimum	0,9	0,5	
Maximum	2,2	1,6	
P(T<=t)	0,0003		0,0000

Table 18: Grams of protein per kg of body weight

3.4.4. Fat consumption

As shown in Table 19, there is no statistically significant difference in fat consumption in athletes and non-athletes. Athletes also met the values recommended for individuals with an increased physical activity (up to 35% of total energy intake). Non-athletes did not meet the recommendation for individuals without increased physical activity (up to 30% of total energy intake).

Percentage of fat covering the total energy intake			**Meeting fat intake recommendations**
	Athletes	Non-athletes	Non-athletes
Arithmetic mean value	31,9	35,5	
Minimum	23,1	16,6	
Maximum	41,3	57,4	
P(T<=t)	0,1081		0,0076

Table 19: Percentage of fat covering the total energy intake

3.4.5. Alcohol consumption

Athletes consumed less alcohol than non-athletes. Athletes met the DACH recommendation for daily alcohol intake for both men (20g) and women (10g). Alcohol consumption is compared in Table 20.

Alcohol consumption (g)		
	Athletes	Non-athletes
Arithmetic mean value	4,3	19,2
Minimum	0,0	0,0
Maximum	22,8	117,4
P(T<=t)	0,0292	

Table 20: Alcohol consumption

3.5. Evaluation of Hypotheses

Hypothesis 1: Athletes have an insufficient energy intake compared to their energy expenditure.

Evaluation of hypothesis 1: This hypothesis was confirmed when underreporting of the energy intake is not considered. Athletes report lower energy intake than energy expenditure.

Hypothesis 2: Non-athletes have higher energy intake than energy expenditure.

Evaluation of hypothesis 2: This hypothesis was not confirmed. Non-athletes have the same energy intake as energy expenditure.

Hypothesis 3: Athletes have an insufficient carbohydrate intake, even though they consume more carbohydrates than non-athletes.

Evaluation of hypothesis 3: This hypothesis was confirmed. Athletes have higher carbohydrate intake than non-athletes while they still do not cover their carbohydrate needs.

Hypothesis 4: Fiber intake is insufficient in both athletes and non-athletes.

Evaluation of hypothesis 4: This hypothesis was not confirmed. Athletes cover their fiber needs, but non-athletes do not cover them.

Hypothesis 5: Sugar intake is higher in athletes than in non-athletes.

Evaluation of hypothesis 5: This hypothesis was confirmed. Sugar consumption is higher in athletes.

Hypothesis 6: Protein intake is higher than required in both athletes and non-athletes.

Evaluation of hypothesis 6: This hypothesis was not confirmed. Athletes consume protein amounts according to their needs. Non-athletes exceed the recommended protein consumption.

Hypothesis 7: Fat intake is within the recommended range in athletes and higher than required in non-athletes.

Evaluation of hypothesis 7: This hypothesis was confirmed. Athletes meet the fat intake recommendations while non-athletes exceed them.

Hypothesis 8: Alcohol consumption is lower in athletes than in non-athletes.

Evaluation of hypothesis 8: This hypothesis was confirmed. Athletes consume less alcohol than non-athletes.

3.6. Discussion

The size of the group of athletes and non-athletes was chosen according to accessible finance, equipment and time requirement and the study should be considered a pilot study. Bigger groups would be needed for more general results and more accurate methods for energy intake calculation and energy expenditure estimation would be needed to ensure reliable results. The study relies on respondents' compliance and self-discipline in reporting the accurate data. However, it shows certain trends and it opens wide possibilities for further research on this topic.

The results show that athletes reported an energy intake that does not cover their increased energy expenditure. However, when underreporting is considered, athletes cover their energy expenditure successfully. There is a question if underreporting should or should not be automatically assumed and further research on this topic is needed. For example, both energy intake and energy expenditure should be measured by two different methods to ensure that the data correspond.

There was no significant difference in the energy intake of athletes and non-athletes which shows that athletes may not realize their increased energy expenditure. The energy expenditure of athletes proved to be significantly higher than in non-athletes, as expected due to an increased physical activity and regular training program.

Underreporting was not further considered in evaluating the nutrient intake, because it cannot be predicted which groups of food would be misreported.

According to the results, athletes consume more carbohydrates than non-athletes. However, they do not meet the recommendations for carbohydrate intake for sportsmen in general. Even though athletes were not divided into groups according to their sport and training program, the carbohydrate consumption discovered in this research was only in the limits for athletes trying to lose weight or for athletes with low-intensity skill-based exercise which was not the case of the studied group. The amount of carbohydrates consumed by athletes would be suitable for non-athletic individuals according to the DACH recommendation. However, the non-athletic participants did not meet this recommendation. The results demonstrate the common fear of carbohydrate consumption in the public which might be a result of misinterpreting dietary recommendations by non-professionals.

Sugar contributed on the total carbohydrate consumption with a higher quota in athletes than in non-athletes, even though athletes reported a fiber consumption according to the DACH recommendation and non-athletes did not. This tendency can for example show a higher consumption of fruits among athletes or awareness of healthy eating habits among athletes in general. Further research on the foods contributing to the carbohydrate intake of athletes, respectively non-athletes would be needed. However, the difference between fiber consumption in athletes and non-athletes is not statistically significant, significant is only the difference of reported consumption and DACH recommendations for fiber intake in non-athletes. A not too high fiber consumption and higher consumption of sugar could be a result of athletes trying to avoid gastrointestinal discomfort during a performance and possibly also a result of choosing easily digestible snacks before, during and after an exercise.

The protein intake is optimal in athletes; however, muscle protein synthesis can be further supported by increasing the carbohydrate intake which decreases the protein oxidation. Even though non-athletes consume less protein than athletes, due to their lower needs of protein, they exceeded the recommended protein intake. However, in the case of athletes, protein is not overconsumed and athletes do not replace their low carbohydrate consumption by an exceeded protein intake.

Athletes also met the recommendations for fat intake. Even though their fat consumption does not differ from that of non-athletes, non-athletes exceeded the recommended fat intake values, because they are 5% lower than for athletes. However, the fat intake recommended for athletes demonstrated the maximal value and since it is counted as a percentage of the total energy intake, it is possible for athletes to lower down the fat intake down to 20 % of the energy intake and replace it by carbohydrates.

Alcohol is the last substance contributing on the total energy intake. However, athletes in average reported only less than a half of the maximal daily alcohol intake recommended for women and less than a quarter of the maximal daily intake recommended for men. Alcohol consumption in athletes is lower than in non-athletes. The reason could be that athletes realize a possible negative influence of alcohol on the performance.

Since athletes meet all the recommended values for nutrients contributing to the energy intake except carbohydrates, there is a clear tendency in underestimating the need of increased carbohydrate intake in sports nutrition. Increased carbohydrate intake can support the performance and can be very beneficial for athletes. Due to increased energy expenditure, athletes do not have to fear gaining weight, because a negative energy balance was commonly discovered.

Another explanation of the results could be underreporting the energy intake and especially the consumption of food consisting of carbohydrates. Athletes might have forgotten to list for example all the sports drinks or sweets consumed in between main meals, even though they were asked about the commonly forgotten items after they sent their reports.

3.7. Conclusion

There is a tendency to underestimate the importance of carbohydrate intake especially among athletes. Athletes seem to cover their energy expenditure insufficiently and the macronutrients contributing to the gap between the energy intake and energy expenditure are mainly carbohydrates. Athletes tend to choose more sugar sources of carbohydrates than non-athletes, while following the fiber intake recommendations. Protein and fat intake were in the range of recommended values, that shows athletes do not choose other nutrients to cover their energy intake. Alcohol consumption among athletes is moderate and no binge-drinking was observed.

List of used acronyms

BMR – basal metabolic rate

BMI – body mass index

TEF – thermic effect of food

TEA – thermic effect of activity

RMR – resting metabolic rate

TEE – total energy expenditure

References:

1. BURKE, Louise. *Practical sports nutrition.* 1. Title. Champaign, IL, USA: Human Kinetics Publishers, 2007. ISBN: 978-0-7360-4695-4.
2. Academy of Nutrition and Dietetics, American College of Sports Medicine, and Dietitians of Canada. Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance. *Journal of the Academy of Nutrition, and Dietetics,* 2016. Vol. 116, Iss. 3, p. 501-528. ISSN: 2212-2672.
3. THIVEL, David et al. Nutritional responses to acute training session in young elite rugby players. *Appetite*, 2015. Vol. 84, p. 316-321. ISSN: 0195-6663.
4. ZIEGLER, Paula J., Satya S. JONNALAGADDA. Nutrient intake is inadequate for US national synchronized skaters. *Nutrition Research,* 2006. Vol. 26, p. 313-317. ISSN: 0271-5317.
5. GARCIN, Murielle et al. Athletes' dietary intake was closer to French RDA's than those of young sedentary counterparts. *Nutrition Research,* 2009. Vol. 29, p. 736-742. ISSN: 0271-5317.
6. GENTON, Laurence, Katarina MELZER and Claude PICHARD. Energy and macronutrient requirements for physical fitness in exercising subjects. *Clinical nutrition*, 2010. Vol. 29, p. 413-423. ISSN: 0261-5614.
7. SPOLEČNOST PRO VÝŽIVU O. S. *Referenční hodnoty pro příjem živin.* 1. Edition. Praha: Výživaservis s.r.o., 2011. ISBN: 978-80-254-6987-3.
8. SOUSA, Mónica et al. Nutritional supplements use in high-performance athletes is related with lower nutritional inadequacy from food. *Journal of sport and Health Science*, 2016. Vol. 5, p. 368-374. ISSN: 2095-2546.
9. DOERING, Thomas et al. Low carbohydrate intake of masters vs. young triathletes in the pre-competition phase of training. *Journal of Science and Medicine in Sport,* 2015. Vol. 195, p. 88-104. ISSN: 1440-2440.
10. BARANAUSKAS Marius et al. Nutritional habits among high-performance endurance athletes. *Medicina*, 2015. Vol. 51, p. 351-362. ISSN: 1010-660X.
11. NOWACKA, Estera et al. Nutritional behavior of Polish canoeist's athletes: The interest of nutritional education. *Science & Sports*, 2016. Vol. 31, p. 79-91. ISSN: 0765-1597.

12. CLOSE, G.L. et al. New strategies in sport nutrition to increase exercise performance. *Free Radical Biology and Medicine,* 2016. Vol. 98, p. 144-158. ISSN: 0891-5849.
13. SOBOTKA, Luboš. *Basics in Clinical Nutrition.* 4. Edition. Praha: Galén, 2011. ISBN: 978-80-7262-821-6.
14. ZLATOHLÁVEK, Lukáš. *Klinická dietologie a výživa.* 1. Edition. Praha: Current Media, s.r.o., 2016. ISBN: 978-80-88129-03-5.
15. GOSTON, Janaina Lavalli, Maria Isabel Toulson Davisson CORREIA. Intake of nutritional supplements among people exercising in gyms and influencing factors. *Nutrition*, 2010. Vol 26, p. 604-611. ISSN: 0899-8007
16. CHAMPAGNE, Catherine M. et al. Day-to-day Variation in Food Intake and Energy Expenditure in Healthy Women: The Dietitian II Study. *Journal of the Academy of Nutrition, and Dietetics,* 2013. Vol. 113, n. 11, p. 1532-1538. ISSN: 2212-2672.
17. BRONNER, Felix. *Nutrition and health*. 1. Edition. Boca Raton, FL, USA: CRC Press, Inc, 1995. ISBN: 0-8493-7849-4
18. OCHNER, Christopher, CONCEICARO, Eva and Olga GORLOVA. The Validity of Nutritional Assessment: Current Status. *Appetite and Nutritional Assessment*. 1. Title. Hauppauge, NY, USA: Nova Science Publishers, Inc., 2009, p. 189-196. ISBN 1607410850.
19. FRANKENFELD, Cara L et al. Dietary Intake Measured from a Self-Administered Online 24-Hour Recall System Compared with 4-Day Diet Records in an Adult US Population. *Journal of the Academy of Nutrition and Dietetics,* 2012. Vol. 112, Iss. 10, p. 1643-1647. ISSN: 2212-2672.
20. BLACK, Alison E., Timothy J. COLE. Biased over- or under-reporting is characteristic of individuals whether over time or by different assessment methods. *Journal of the American Dietetic Association,* 2001. Vol. 101, Iss. 1, p. 70-80. ISSN: 0002-8223.
21. SGAGLIUSI, Fernanda B. et al. Inderreporting of Energy Intake in Brazilian Women Varies According to Dietary Assessment: A Cross-Sectional Study Using Doubly Labeled Water. *Journal of the American Dietetic Association,* 2008. Vol 108, Iss. 12, p. 2031-2040. ISSN: 0002-8223.
22. MILLEN, Amy E. et al. Differences between Food Group Reports of Low-Energy Reporters and Non-Low-Energy Reporters on a Food Frequency Questionnaire. *Journal of the American Dietetic Association,* 2009. Vol. 109, p. 1194-1203. ISSN: 0002-8223.

23. GJORESKI, Hristijan et al. Contex-based ensemble method for human energy expenditure estimation. *Applied Soft Computing,* 2015. Vol. 37, p. 960-970. ISSN: 1568-4969.
24. FRANKENFIELD, David, ROTH-YOUSEY, Lori and Charlene COMPHER. Comparison of Predictive Equations for Resting Metabolic Rate in Healthy Nonobese and Obese Adults: A Systematic Review. *Journal of the American Dietetic Association,* 2005. Vol. 105, n. 5, p. 775-789. ISSN 0002-8223.
25. KOHN, Jill Balla. Adjusted or Ideal Body Weight for Nutrition Assessment? *Journal of the Academy of Nutrition and Dietetics*, 2015. Vol. 115, Iss. 4, p. 680. ISSN: 2212-2672.
26. AINSWORTH, Barbara E. et al. 2011 Compendium of Physical Activities: A Second Update of Codes and MET Values. *Medicine & Science in Sports & Exercise,* 2011. Vol. 43, Iss. 8, p. 1575-1581. ISSN: 0195-9131.
27. *Harris-Benedict Calculator* [online]. ©2008 [2016-12-28]. Accessed from: *http://www.nafwa.org/harrisbenedict.php*
28. *Compendium of Physical Activities* [online]. [2016-12-28]. Accessed from: *https://sites.google.com/site/compendiumofphysicalactivities/home*

Appendix

Instructions for the Food and Physical Activity Report

Dear volunteers,

as a student of nutrition therapy on the 1. Faculty of Medicine, Charles University, I am currently working on my master thesis called Monitoring of carbohydrate intake in sportsmen's diet. The supervisor of the thesis is MUDr. Zdeněk Vilikus, CSc. In the practical part, I compare a food and physical activity diaries of athletes and non-athletes over 5 consecutive days of which at least one is a weekend day. The goal is to find differences between athletes' and non-athletes' food habitats with a closer attention on carbohydrate consumption.

I would like to ask you to be so kind and make a following report for me. You will find all necessary specifications and instructions in the following text. Please send all the documents and potential questions to the e-mail address: pourovaveroni@gmail.com

Thank you kindly,

Bc. Veronika Pourová

Instructions:

1. Food diary

Food diary is a detailed report of all the foods and drinks consumed during 5 consecutive days, including at least one weekend day. On the first day of the report, please weigh yourself and note the number. Please do so before breakfast and possibly after going to the bathroom. Note also your height, age and sex.

Please do not modify your diet during the report and if there is an unusual event (vacation, illness…), please start with the report afterwards. Please do not forget to note all the drinks and alcohol. To increase precision, please note the food in the time of consumption.

If you know the exact name of a product, please write it down. If there is a weight on the package, please write it down. If there is no weight on the package or you eat only a part of it, please weigh the item. Try to weigh everything before cooking, however, if there is no opportunity to do so, please note that you weighed it cooked. If you have no opportunity to weigh the food (for example while eating outside), you can use a table with household

measures. Please check the menu in a restaurant and see if there is a weight noted. You can also take a picture of a meal if you are not sure about the amount and attach it to the documents. You can use an excel table, a notebook or a phone according to what suits you the best.
In the morning reporting the last day, please weigh yourself once again (before breakfast, after going to the bathroom) and note the number.

2. Physical activity diary

Please report all your physical activity in the same days like the food diary. Please, note the activity as detailed as possible. Please write down the time of sleep, studying, working, relaxing, driving a car, cooking, training, walking etc.
A detailed report will help to make a guess of your energy expenditure as exact as possible, I would appreciate your cooperation.
The physical activity will be evaluated using the Compendium of Physical Activities. If you do not wish to report all your activity, you can also have a look at the website and only the time of duration and a MET value. You will find all the MET values on this website: https://sites.google.com/site/compendiumofphysicalactivities/Activity-Categories
Following activities will be evaluated:

1	Bicycling	8	Lawn & Garden	15	Sports
2	Conditioning Exercise	9	Miscellaneous	16	Transportation
3	Dancing	10	Music Playing	17	Walking
4	Fishing & Hunting	11	Occupation	18	Water Activities
5	Home Activities	12	Running	19	Winter Activities
6	Home Repair	13	Self-Care	20	Religious Activities
7	Inactivity	14	Sexual Activity	21	Volunteer Activities

Physical activity report can have two forms; you can also combine them.

Form n. 1: activity type	Form n. 2: MET values only
8 h sleeping	8 h: 0,95
2 h cooking	2 h: 2,5
1 h cycling 20 km/h	1 h: 8,0
3 h studying	3 h: 1,3
2 h watching movie, lying	2 h: 1,3
1 h dog walking	1 h: 3,0
10 min walking up the stairs slowly	10 min: 4,0
1 h eating	1 h: 1,5
30 min cleaning	30 min: 3,3
30 min piano playing	30 min: 2,3
Remaining time: walking in the house	Remaining time: 2,0

List of Tables

EVIDENCE VÝPŮJČEK

Prohlášení:
Beru na vědomí, že odevzdáním této závěrečné práce poskytuji svolení ke zveřejnění a k půjčování této závěrečné práce za předpokladu, že každý, kdo tuto práci použije pro svou přednáškovou nebo publikační aktivitu, se zavazuje, že bude tento zdroj informací řádně citovat.

V Praze, 30.4.2015

Jako uživatel potvrzuji svým podpisem, že budu tuto práci řádně citovat v seznamu použité literatury.

Jméno	**Ústav / pracoviště**	**Datum**	**Podpis**